Telecom Datacom And Networking For Non Engineers By Eric Coll

Telecom, Datacom and Networking for Non EngineersVoIP 101Telecom Services OverviewTCO CWA Study GuideThe Internet and Cloud ComputingMPLS and Carrier NetworksMobilityLegacy Technology: All About T1Fundamentals of Voice over IPDigital Media: Voice, Video, Images, Quantities, TextWireless TelecommunicationsThe PSTN and Broadband on CopperNetwork Quality: CoS, QoS, MPLS and SLAsLTE and 5GSIP Trunking & Carrier ConnectionsVoice Packetization, Codecs and Voice QualityIP Networks, Routers and AddressesLegacy 2G and 3G TDMA and CDMAResources in educationThe OSI Layers and Protocol Stacks Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll Eric Coll

eight in one telecom datacom and networking for non engineers is a subset of the 550 page telecom 101 stripped down to the core eight chapters corresponding to the eight ctns courses key chapters delivering the core telecommunications and telecom network knowledge needed by anyone serious in telecom today in plain english 1 introduction to broadband converged ip telecom 2 wireless telecommunications 3 fundamentals of voice over ip 4 the pstn 5 osi layers and protocol stacks 6 lans vlans wireless and optical ethernet

7 ip addresses packets and routers 8 mpls and carrier networks based on the world renowned tco ctns certification courses training developed refined and tuned over many years the selection of material its order and emphasis is proven and field tested to bring you the knowledge you need our approach can be summed up with a simple philosophy start at the beginning progress in a logical order build one concept on top of another finish at the end avoid jargon bust the buzzwords demystify jargon and cut through doubletalk fill in the gaps build a solid base of knowledge put a structure in place and show how everything fits together knowledge and understanding that lasts a lifetime understanding what everything does and how it all works together allows you to be more accurate eliminates frustration with buzzwords being left out of discussions giving you confidence to make meaningful contributions you have the added advantage of knowing what someone is talking about even if you re not familiar with the exact details of the variation they re discussing telecom datacom and networking for non engineers is ideal for anyone needing a book covering the essential core knowledge in telecommunications in plain english in one book you get consistency completeness and unbeatable value a wealth of clear concise organized knowledge impossible to find in one place anywhere else telecom datacom and networking for non engineers has two parts first a deep dive into telecom introduction to broadband converged ip telecom wireless telecommunications fundamentals of voice over ip and the pstn then a deep dive into datacom and networking osi layers and protocol stacks lans vlans wireless and optical ethernet ip addresses packets and routers and mpls and carrier networks let s get started

voip 101 is designed for the non engineering professional needing an overview and update and for those new to the business needing to get up to speed quickly voip 101 covers all major topics in voice over ip in plain english from fundamentals to softswitches and sip trunking we ll explain the jargon and the technologies and more importantly the underlying ideas based on training courses developed refined and tuned over many years the selection of material its order and emphasis in voip 101 is proven and field tested to bring you the knowledge of voice over ip you need understanding what everything does and how it all works together allows you to be more accurate eliminates frustration with buzzwords and gives you confidence to make meaningful contributions you have the added advantage of knowing what someone is talking about even if you re not familiar with the exact details of the variation they re discussing don t be the one person in the room who isn t up to speed your employer or prospective employer will be interested to hear you have this solid

foundation of knowledge that project and product specific knowledge can be built on getting you up to speed quickly then having the versatility to subsequently work on different projects voip 101 has six chapters covering all aspects of voice over ip including all the different ways voip is implemented how calls are set up with softswitches and sip how voice is packetized the factors affecting sound quality connecting to carriers and sip trunking and network quality with mpls service level agreements and class of service 1 fundamentals of voice over ip a complete introduction to everything voice over ip you ll learn the fundamental ideas and principles of a voip telephone system the jargon and buzzwords and how it all works together 2 voip architectures and implementation choices next is a comprehensive overview of the many flavors of voip comparing and contrasting the various implementation and architecture choices 3 softswitches sip call setup and sip trunking this chapter is all about sip and how it is used to set up phone calls what sip is how it works jargon like proxy server and location server how sip fits in with softswitches and call managers and trace the establishment of a voip phone call using sip and dns step by step 4 voice packetization codecs and voice quality the nuts and bolts of voice over ip how the voice is digitized and coded time stamps applied with the rtp protocol and how the result is carried in udp ip packets and mac frames 5 sip trunking carrier connections this chapter is all about connecting to carriers to communicate voip phone calls both carrier to carrier connections and business to carrier sip trunking 6 ip network quality cos qos mpls and slas the last chapter in voip 101 focuses on the network service provided by carriers to move voip packets and how network traffic is identified managed and prioritized resulting in class of service offerings to meet service level agreements voip 101 is intended to be read sequentially building ideas on top of ideas the detailed table of contents makes it also useful as a day to day reference handbook our goal is to explain the big picture the jargon and buzzwords and put in place a very solid base of voip knowledge spanning fundamentals to the latest technologies and how they are deployed in plain english let s get started

telecom services overview no foundation in telecom would be complete without understanding where the money is services with the holy grail of recurring billing we ll organize services into residential business and wholesale and identify today s standard choices and offerings in each area we ll cover for residences broadband internet plus internet voip with pstn phone number and streaming video in the business category vpns sd wan sip trunking pri and centrex and wholesale services dark fiber wavelengths carrier ethernet and ip transit the module is completed with content delivery networks telecom

module 5 detailed outline 5 telecom services overview 5 1 residential services 5 1 1 broadband internet 5 1 2 convergence achieved 5 1 3 pstn phone numbers 5 1 4 voip service providers internet to pstn service 5 1 5 basic cable streaming rentals 5 1 6 dedicated capacity for tv vsinternet traffic 5 2 business data services 5 2 1 internet 5 2 2 private network dedicated lines 5 2 3 virtual private network 5 2 4 mpls vpns 5 2 5 sd wan 5 2 6 services 5 3 business voice services 5 3 1 sip trunking voip between locations dial out 5 3 2 connecting voip to ma bell 5 3 3 sip trunking lower cost than pbx trunks 5 3 4 centrex 5 3 5 private branch exchange pbx trunks 5 3 6 isdn pri 5 3 7 tie lines and voice vpns 5 4 wholesale services 5 4 1 facilities based carriers 5 4 2 value adding resellers 5 4 3 services dark fiber 5 4 4 wavelengths 5 4 5 carrier ethernet 5 4 6 ip services 5 4 7 internet transit 5 4 8 internet peering 5 4 9 bit rates 5 5 content delivery networks 5 5 1 paying transit for data center to consumer 5 5 2 cutting out the middlemen 5 5 3 implementing a content delivery network

the cwa study guide is an essential enhancement to the tco certified wireless analyst certification package this study guide the course book contains detailed notes and graphics corresponding exactly to the cwa lessons this book therefore contains all of the answers to the cwa exam questions having a companion reference textbook avoids the need to take notes and greatly enhances learning and retention helping you learn and burn the concepts into the neurons of your brain this course book is also a valuable day to day reference handbook and glossary on its own independent of the online courses the tco certified wireless analyst certification courses deliver the core technical knowledge needed by anyone serious in the wireless business today with high quality self paced courses you ll gain broad knowledge spanning radio and spectrum fundamentals digital radio and qam modems mobility concepts and network design radio technologies from amps to lte and 5g s ofdma 5g mmwave ultra broadband and low power low bitrate 5g for iot wi fi 6 802 11ax broadband wireless internet point to point microwave low earth orbit satellites and more and tco certified wireless analyst certification to prove it body language conveys a surprisingly large amount of information students who find they learn more from a person than from computer generated images will appreciate that many of the lessons are video taught to you by our charming and entertaining instructor directly into the camera with overlaid bullets and graphics on screen the detailed text notes in this optional study guide are a recommended enhancement to the online courses included in the cwa certification package the cwa certification package includes three online certification courses and the tco cwa certification

exam both with unlimited repeats which means guaranteed to pass and refresh your knowledge anytime course 2231 wireless fundamentals radio fundamentals radio spectrum radio bands allocations and allotments digital radio how modems work course 2232 mobile communications cellular principles mobility and handoffs pstn phone calls mobile internet 4g lte and 5g new radio fdma gsm tdma cdma ofdm and ofdma mvnos and roaming course 2233 fixed wireless wireless lans 802 11 standards wi fi wi fi security bluetooth lpwa networks for iot broadband wireless home internet point to point microwave leo and geo satellites visit teracomtraining com for more information and print copies of the tco certified wireless analyst cwa study guide

the internet cloud computing and data centers the internet which started out as a way to send text email messages is now worldwide converged broadband communications in this module we ll understand what exactly an internet service provider does and how they get packets delivered world wide we ll review web clients browsers and apps web servers then understand the huge business of web services cloud computing and data centers you ll also learn about all the different types of vpn and how sd wan services are internet vpns we ll finish with a discussion of net neutrality telecom module 4 detailed outline 4 the internet and cloud computing 4 1 a network to survive nuclear war 4 1 1 connectionless network service 4 1 2 al gore invents the internet 4 1 3 who pays for the internet 4 1 4 primitive beginnings 4 2 the inter net protocol 4 2 1 gateways 4 2 2 ip common packet format and address scheme 4 2 3 connectionless unreliable network service 4 2 4 tcp and udp 4 2 5 routing protocols 4 3 internet service providers isps 4 3 1 internet access providers 4 3 2 the internet is a business 4 3 3 interconnect peering and transit 4 3 4 resellers 4 4 domain name system 4 4 1 dns servers 4 4 2 domain zone files 4 4 3 sip records in dns 4 5 clients 4 5 1 browsers 4 5 2 apps 4 5 3 iot apps 4 6 servers 4 6 1 http 4 6 2 https 4 6 3 html 4 6 4 hrefs and urls 4 7 services and cloud computing 4 7 1 server and back end 4 7 2 doing it yourself dynamic dns 4 7 3 hosting 4 7 4 virtualization and cloud computing 4 7 5 amazon aws microsoft azure 4 8 data centers 4 8 1 commercial multi tenant data centers 4 8 2 collocation 4 8 3 heat and electricity 4 8 4 connections to internet exchanges 4 9 internet vpns 4 9 1 tunnels implemented with encryption 4 9 2 ip vpn vsmpls vpn 4 9 3 country spoofing vpns 4 9 4 anonymizer vpns 4 10 sd wan 4 10 1 pairwise internet vpn tunnels 4 10 2 no guarantees 4 10 3 bandwidth management 4 10 4 implementation and standards 4 10 5 service bundling 4 11 net neutrality 4 11 1 no corporate or government interference 4 11 2 relayed without regard for content senders or receivers 4 11 3 many different meanings 4 11 4 criminal

activities 4 11 5 transparency 4 11 6 devil in the details 4 11 7 no meters 4 11 8 zero rating

mpls and carrier networks ip packets will be used to carry everything including phone calls and television but ip in itself does not include any way to prioritize or manage ip packets to guarantee call quality or video quality in the core of a carrier s network mpls is used to implement those functions in this module you ll learn the basics of carrier networks and the important concept of a service level agreement then you ll gain a practical understanding of how mpls works and how it is used by carriers to implement vpns different classes of service service integration and traffic aggregation telecom module 15 detailed outline 15 mpls and carrier networks 15 1 introduction 15 1 1 overbooking 15 1 2 congestion contention and packet loss 15 1 3 class of service cos 15 2 carrier packet network basics 15 2 1 provider edge pe and customer edge ce 15 2 2 access 15 2 3 advantages of packet networks 15 3 service level agreements 15 3 1 traffic profile 15 3 2 contract 15 3 3 business decisions 15 3 4 enforcement out of profile traffic 15 3 5 abusive applications 15 4 provider equipment at the customer premise 15 5 virtual circuit technologies 15 5 1 ip routing vscentralized control 15 5 2 traffic classes 15 5 3 virtual circuits 15 5 4 svcs and pvcs 15 5 5 ingress device packet classification 15 5 6 forwarding based on class number 15 5 7 differentiated services 15 6 mpls 15 6 1 mpls vstcp 15 6 2 forwarding equivalence class 15 6 3 labels and label stacking 15 6 4 label switched path 15 6 5 ip user network interface 15 6 6 label edge routers 15 6 7 label switching router operation 15 7 mpls vpn service for business customers 15 7 1 private network service 15 7 2 virtual private network vpn 15 7 3 internet vpns 15 7 4 mpls vpn 15 8 mpls and diff serv to support class of service 15 8 1 ds codepoints 15 8 2 assured forwarding and expedited forwarding 15 9 mpls for integrated access 15 9 1 sip trunking vpn and internet on one access 15 10 mpls for traffic aggregation 15 10 1 label stacking 15 11 m is for multiprotocol virtual private lan service vpls

mobility with a good foundation in place we ll cover mobile communications from a to z cellular principles digital voice phone calls to the pstn and mobile internet this is where the money is wireless module 2 detailed outline 2 mobility 2 1 mobile network components and operation 2 1 1 mobile network and mobility 2 1 2 handset sim card and imsi 2 1 3 airlink base station towers and cells 2 1 4 mobile telephone switching office 2 1 5 backhaul and network connections 2 1 6 incoming call and paging 2 1 7 mobility and handoffs 2 2 cellular principles 2 2 1 coverage capacity and mobility requirements 2 2 2 first generation 2 2 3 cellular design to meet the coverage objective 2 2 4 frequency re use 2 2 5 handoffs 2 3 1g

analog frequency division multiple access 2 3 1 amps nmt and tacs 2 3 2 frequency division multiplexing 2 3 3 frequency re use 2 3 4 analog fm 2 3 5 difficulties 2 3 6 eavesdropping 2 3 7 modem disconnect during handoff 2 3 8 low capacity 2 4 pstn calls using the native phone app voice minutes 2 4 1 voice communication end to end 2 4 2 coding 2 5 mobile internet data plan 2 5 1 data is internet traffic 2 5 2 using the built in modem 2 5 3 tethered modem 2 5 4 wi fi and bluetooth links 2 5 5 smartphones 2 5 6 data plans 2 5 7 converged communications converged device achieved 2 6 mobile network operators mvnos roaming 2 6 1 mobile network operator 2 6 2 mobile virtual network operator 2 6 3 roaming

legacy technology all about t1 this module provides detailed information on the carrier system technology called t1 t1 used to be a principal subject of telecommunications courses but is now relegated to the back of the book as t1 is a technology running at 1 5 mb s on copper wires replaced with gigabit s optical ethernet on fiber that said there are thousands of t1 circuits installed and in use and some readers of this book have picked it precisely to learn about t1 because they have been tasked with supporting it or auditing an existing installation power companies the military and government still have t1s in place along with t1s at big organizations that are no longer being used but have been forgotten and are still being paid for each month a small but appreciated part of any phone company s revenue this chapter on t1 also provides a very detailed explanation of synchronous time division multiplexing framing and channels since the principles of operation of legacy sonet fiber optic transmission systems are the same as t1 learning about t1 is also learning about sonet telecom module 18 detailed outline 18 legacy technology all about t1 18 1 t1 history and applications 18 2 t1 circuit components 18 3 operation 18 4 t1 framing 18 4 1 superframe format 18 4 2 esf 18 5 pulses and line code ami 18 5 1 repeaters 18 6 synchronization bit robbing 18 7 56 kb s for data 18 8 b8zs and 64 kb s clear channels 18 9 how t1 is provided 18 9 1 hdsl 18 10 fractional t1 dacs and cross connects 18 11 subrate data circuits 1 2 kb s to 56 kb s 18 11 1 csus dsus and csu dsus

fundamentals of voice over ip a complete introduction to everything voice over ip you ll learn the fundamental ideas and principles of a voip telephone system the jargon and buzzwords and how it all works together you ll learn how voice is carried in packets end to end voip phones call managers and softswitches cloud services sip and sip trunking voip on lans and wans and the future voip module 1 detailed outline 1 fundamentals of voice over ip 1 1 introduction 1 2 voip phones 1 2 1 computers that look like telephones 1 2 2 voip phone

functions 1 2 3 quality of service and differentiated services 1 2 4 computer as the terminal 1 2 5 voip over cellular 1 2 6 summary 1 3 voice in ip packets 1 3 1 voice in ip packets end to end 1 3 2 missing or delayed packets 1 4 sip and soft switches sip servers call managers 1 4 1 introduction 1 4 2 hard switch 1 4 3 soft switch 1 4 4 functions of a soft switch 1 4 5 soft switch terminology 1 5 media servers 1 5 1 introduction 1 5 2 integrated messaging server 1 5 3 video server 1 5 4 other types of media servers 1 6 gateways 1 6 1 introduction 1 6 2 media conversion 1 6 3 signaling conversion 1 7 voip over lans and wans 1 7 1 introduction 1 7 2 lans 1 7 3 wans 1 8 key voip standards 1 8 1 introduction 1 8 2 ietf standards 1 8 3 itu t standards 1 8 4 ieee lan standards 1 8 5 tia cable standards 1 9 broadband ip dial tone 1 9 1 the ip pstn 1 9 2 ip dial tone 1 9 3 the internet and the telephone network become one 1 9 4 value added services

digital media voice video images quantities and text the converged network carries all media voice video text and images in packets an essential first step is digitizing the media representing it using 1s and 0s to be carried in said packets we ll first understand analog vs digital how voice is digitized and reconstructed the g 711 64 kb s and amr codec standards the same principles apply to images and video in formats like jpg and mp4 video we ll make sure you are up to speed on binary and hexadecimal for quantities and finish with ascii and unicode for coding keystrokes and emojis telecom module 6 detailed outline 6 digital media voice video images quantities text 6 1 analog and digital what do we really mean 6 1 1 analog signal 6 1 2 analog circuit 6 1 3 digital signal 6 1 4 digital circuit 6 1 5 bandwidth 6 2 continuous vsdiscrete signals 6 2 1 continuous signals 6 2 2 discrete signals 6 3 voice digitization analog digital conversion 6 3 1 quantization 6 3 2 sampling 6 3 3 coding 6 4 voice reconstruction digital analog conversion 6 4 1 reconstruction 6 4 2 quantization error 6 4 3 aliasing error 6 5 voice digitization 64 kb s g 711 standard 6 5 1 256 quantization levels 6 5 2 8 000 samples per second 6 5 3 8 bit coding 6 5 4 64 kb s g 711 codec standard 6 5 5 64 kb s ds0 channels 6 5 6 64 kb s packetized voice 6 5 7 amr codec for cellular 6 5 8 mu law and a law 6 6 digital video h 264 and mpeg 4 6 6 1 digital video cameras 6 6 2 factors affecting video quality 6 6 3 definition vsresolution 6 6 4 standard definition interlaced and 480i 6 6 5 high definition progressive and 720p 6 6 6 full hd 1080 and 2k 6 6 7 ultra hd 4k 8k 4m 6 6 8 compression 6 6 9 mpeg 6 6 10 mpeg 4 and h 264 6 7 digital images jpegs and gifs 6 7 1 lossless compression png 6 7 2 lossy compression jpeg and gif 6 8 digital images in email mime 6 8 1 uuencode quoted printable and base 64 encoding 6 9 digital quantities number systems 6 10 digital quantities binary 6 11 digital quantities hexadecimal 6 11 1

common use for hexadecimal 6 12 digital text 6 12 1 ascii 6 12 2 unicode

wireless telecommunications in this comprehensive module you will learn all about wireless transmission beginning with the radio spectrum we ll identify the components and basic principles of operation of a mobile network you ll understand the requirements for coverage capacity and mobility and why cellular radio systems are used you ll learn how mobile to pstn phone calls are connected how mobile internet works along with roaming and virtual network operators you ll learn about ofdma 4g lte and 5g for mobile and for 3 5 ghz fixed wireless home internet we ll cover wifi and the latest wi fi 6 802 11ax standard and finish with satellite communications and starlink telecom module 7 detailed outline 7 wireless telecommunications 7 1 radio 7 2 spectrum 7 2 1 the need for regulation 7 2 2 radio spectrum 7 2 3 capacity vsperformance tradeoff 7 2 4 two way radio fdd or tdd 7 2 5 frequency bands 7 2 6 600 mhz band 7 2 7 700 mhz band 7 2 8 800 900 1800 and 1900 mhz bands 7 2 9 2 4 ghz and 5 ghz unlicensed bands 7 2 10 2 5 ghz band 7 2 11 3 5 ghz band 7 2 12 3 7 ghz c band 5g 7 2 13 millimeter wave bands 7 3 mobile network components and operation 7 3 1 0g the mobile phone system 7 3 2 mobility 7 3 3 base station cell airlink handset and sim 7 3 4 mobile switch 7 3 5 backhaul 7 3 6 registration and paging 7 3 7 handoff 7 4 cellular principles 7 4 1 amps the advanced mobile phone system 7 4 2 cells 7 4 3 frequency re use 7 4 4 1g analog frequency division multiple access 7 4 7 sectorization 7 5 second generation digital 7 5 1 pcs and gsm 7 6 pstn phone calls using the phone app voice minutes 7 6 1 the native telephone app 7 6 2 speech digitized and packetized in the phone 7 6 3 radio frequency modem 7 6 4 antenna 7 6 5 the base station 7 6 6 backhaul to mobile switch and call routing 7 6 7 speech coding standards and bit rates 7 6 8 connection to the pstn 7 7 mobile internet data plan 7 7 1 cellphone as a tethered modem 7 7 2 mobile wi fi hotspot 7 7 3 packet relay to the internet 7 7 4 dongles 7 7 5 smartphone as the terminal 7 7 6 billing plans and roaming 7 7 7 the holy grail of convergence 7 8 mobile operators mvnos and roaming 7 9 3g cdma and hspa 7 9 1 imt 2000 7 9 2 1x or cdma2000 imt mc 7 9 3 umts or w cdma imt ds 7 9 4 data optimized carriers hspa and ev do 7 9 5 the end of the standards war 7 10 4g lte mobile broadband 7 10 1 universal terrestrial radio access network long term evolution 7 10 2 radio resource controller 7 10 3 ofdm 7 10 4 3gpp standards committees 7 10 5 qualcomm patents 7 11 5g nr enhanced mobile broadband iot communications 7 12 spectrum sharing roundup fdma tdma cdma ofdma 7 13 3 5 ghz fixed wireless broadband home internet 7 14 wi fi 802 11 wireless lans 7 14 1 system components 7 14 2 service set id 7 14 3 unlicensed radio bands

7 14 4 half duplex 7 14 5 802 11b and g 7 14 6 802 11a 7 14 7 wi fi 4 802 11n 7 14 8 wi fi 5 802 11ac 7 14 9 wi fi 6 802 11ax 7 14 10 voip over wireless lans 7 14 11 wi fi security 7 15 communication satellites 7 15 1 transponders 7 15 2 geosynchronous orbit 7 15 3 low earth orbit 7 15 6 starlink

the pstn and broadband on copper before wireless and fiber two copper wires were used for the physical access circuit for telephone and cable tv service in suburbs and cities today these wires are also used to deliver broadband in this module we ll understand how dsl broadband service runs on twisted pairs put in place for analog pots telephone service how cable modems move broadband on coaxial cable and how both are delivered as fiber to the neighborhood then copper to the premise to finish up we ll review digital on copper wires lan cables and t1s telecom module 9 detailed outline 9 the pstn and broadband on copper 9 1 the public switched telephone network 9 1 1 basic model of the pstn 9 1 2 loops 9 1 3 trunks and circuit switching 9 1 4 remotes 9 1 5 dsl and dslams in brownfields 9 1 6 greenfields pons on fiber to the premise 9 1 7 active ethernet to the premise 9 2 analog 9 2 1 analog signals 9 2 2 analog circuits 9 3 capacity restrictions 9 3 1 what is speech 9 3 2 do trees falling in the forest make a sound 9 3 3 the voiceband 9 3 4 bandwidth 9 3 5 why does the voiceband stop at 3300 hz 9 3 6 problems with voiceband restrictions 9 4 problems with analog transmission 9 4 1 attenuation and amplifiers 9 4 2 electro magnetic interference 9 4 3 crosstalk 9 4 4 impulse noise 9 5 plain ordinary telephone service pots 9 5 1 tip and ring 9 5 2 twisted pair 9 5 3 line card 9 5 4 microphone and speaker 9 5 5 balanced signaling 9 5 6 two way simultaneous 9 5 7 hybrid transformer 9 5 8 battery 9 5 9 lightning protection 9 5 10 supervision 9 5 11 call progress tones 9 6 network addresses telephone numbers 9 6 1 dialing plan 9 6 2 address signaling 9 6 3 pulse dialing 9 6 4 dtmf touch tone 9 6 5 in band signaling 9 6 6 hidden buttons 9 6 7 caller id 9 7 digital subscriber line dsl 9 7 1 dsl modems above the voiceband 9 7 2 adsl sdsl and xdsl 9 8 dslams 9 8 1 coexistence with pots 9 9 fiber to the neighborhood fttn dsl to the premise 9 9 1 loop length 9 9 2 remote dslams opi and sac boxes 9 10 dsl standards 9 10 1 adsl2 9 10 2 vdsl2 9 10 3 vdsl2 frequency bands and profiles 9 10 4 pair bonding 9 10 5 vectoring 9 11 broadband carriers fttn broadband coax to the premise 9 11 1 hybrid fiber coax network 9 11 2 frequency channels 9 11 3 fiber serving area 9 11 4 television converters 9 11 5 modems on catv channels 9 11 6 two way communications over a shared cable 9 12 docsis and cable modem standards 9 12 1 docsis 1 contention based channel sharing 9 12 2 docsis 2 reserved time slots on channels 9 12 3 docsis 3 cdma on channels 9 12 4 docsis 3 1 ofdm 9 12 5 wider channels 9 13 t1 and e1 9

13 1 time division multiplexers 9 13 2 ds1 frames 9 13 3 csus and repeaters 9 13 4 synchronization 9 13 5 applications for t1 9 13 6 e1 outside north america 9 13 7 tdm on fiber 9 14 tia 568 lan cable categories 9 14 1 category 1 through 5 9 14 2 tia 568a vstia 568b 9 14 3 maximum cable length and cabling architecture 9 14 4 difference between categories 9 14 5 which category to use

ip network quality cos qos mpls and slas this module focuses on the network service provided by carriers to move voip packets and how network traffic is identified managed and prioritized resulting in class of service offerings to meet service level agreements you will learn about service level agreements how carriers use mpls to manage flows of packets differentiated services different transmission characteristics for different kinds of traffic and classes of service cos voip module 6 detailed outline 6 ip network quality cos qos mpls and slas 6 1 virtual circuit technologies 6 1 1 packet by packet routing 6 1 2 virtual circuits 6 1 3 centralized control of routing tables 6 1 4 prioritization 6 1 5 mpls replaces legacy technologies 6 2 mpls 6 2 1 mpls to implement virtual circuits 6 2 2 labels and forwarding equivalent classes 6 2 3 label stacking 6 2 4 label switched path calculation 6 2 5 label switching routers and label processing 6 2 6 user network interface ip 6 3 differentiated services diff serv 6 3 1 different transmission characteristics 6 3 2 classification 6 3 3 implementation 6 4 meters markers shapers and droppers 6 4 1 traffic management 6 4 2 traffic management functions 6 5 interworking diff serv and mpls 6 5 1 similarities between mpls and diff serv 6 5 2 diff serv codepoint in mpls header 6 5 3 diff serv codepoint associated with label 6 6 using 802 1p for qos 6 6 1 frame level priority tag 6 6 2 802 1p as an input to ds classification 6 7 implementing cos queuing techniques 6 7 1 implementing prioritization 6 7 2 priority queuing 6 7 3 weighted round robin queuing

lte and 5g in the third wireless module we cover the 4g and 5g technology understanding how both use ofdm for spectrum sharing and ofdma for simultaneous communication with many users wireless module 3 detailed outline 3 lte and 5g 3 1 4g lte mobile broadband 3 1 1 introduction 3 1 2 lte for the utran 3 1 3 modems modulation and how ofdm moves 6 bit numbers simultaneously to different people on the same carrier 3 1 4 modulation 3 1 5 communicating six bits sending one of 64 qam signals 3 1 6 baud rate equal to subcarrier spacing 3 1 7 lte specification and ofdma 3 1 8 3gpp releases 3 1 9 the eventual pivot to 5g across the spectrum 3 2 dynamic assignment of subcarriers 3 2 1 1g vs 4g and 5g 3 3 5g new radio enhanced mobile broadband iot communications 3 3 1 introduction 3 3 2 3gpp

release 15 3 3 3 immediate impact of 5g more bits per second 3 3 4 new spectrum 3 3 5 millimeter wave 3 3 6 5g design goals and use cases 3 3 7 enhanced mobile broadband 3 3 8 massive machine type communication 3 3 9 ultra reliable low latency communications 3 4 spectrum sharing roundup fdma tdma cdma ofdma 3 4 1 fdma 3 4 2 tdma 3 4 3 cdma 3 4 4 ofdm and ofdma

sip trunking carrier connections this module is all about connecting to carriers to communicate voip phone calls both carrier to carrier connections and business to carrier sip trunking you ll learn how competitive carriers terminate voip phone calls on local exchange carriers using the switched access tariff and tandem access trunks we ll understand why this will be a native voip connection in the future and the role of session border controllers then we ll understand how a business system can connect its locations and to the pstn using sip trunking services and the advantage over the legacy isdn pri pbx trunks voip module 5 detailed outline 5 sip trunking and carrier connections 5 1 carrier to carrier connection via tandem access trunks 5 1 1 internet vsp to lec 5 1 2 generalized carrier carrier example 5 1 3 competitive long distance 5 2 carrier to carrier voip interconnection 5 2 1 native voip interconnect 5 2 2 issues to resolve 5 3 session border controllers 5 3 1 mpls core 5 3 2 sip trunking 5 3 3 security lawful intercept and call routing 5 3 4 spam filtering 5 4 pbx trunks and gateways 5 4 1 business phone system pstn connectivity 5 4 2 legacy pbxs and pbx trunks 5 4 3 replacing the pbx with a softswitch 5 4 4 using a gateway 5 4 5 intelligent gateway invisible to the softswitch 5 5 megaco softswitch controlling the gateway 5 5 1 non intelligent gateway 5 5 2 softswitch tells the gateway what to do 5 5 3 media gateway control protocol megaco 5 6 sip trunking 5 6 1 pbx trunk replacement 5 6 2 advantages 5 6 3 challenges

voice packetization codecs and voice quality the nuts and bolts of voice over ip how voice is digitized and coded time stamps applied with the rtp protocol and how the result is carried in udp ip packets and mac frames you ll learn about codecs and compression and understand factors like delay jitter and packet loss what causes them and how they affect sound quality voip module 4 detailed outline 4 voice packetization codecs and voice quality 4 1 voice packetization 4 1 1 microphone produces a voltage analog 4 1 2 digitization 4 1 3 coding 4 1 4 segmentation and packetization 4 2 measuring voice quality 4 2 1 mean opinion score 4 2 2 toll quality speech 4 3 factors affecting voice quality 4 3 1 codec delay jitter and packet loss 4 3 2 network load 4 4 codecs and compression 4 4 1 coder decoder 4 4 2 tradeoffs 4

4 3 cbr vs vbr 4 4 4 standards 4 5 delay 4 5 1 coding delay 4 5 2 network delay 4 5 3 design goal 4 6 jitter 4 6 1 ip no guarantees 4 6 2 variable delivery time 4 6 3 variable network loading 4 6 4 jitter buffer 4 7 rtp 4 7 1 real time transport protocol 4 7 2 segmentation 4 7 3 time stamp 4 7 4 error recovery 4 8 voip protocol stack rtp udp ip mac 4 8 1 moving the rtp pdu 4 8 2 udp error detection and recovery 4 8 3 port number 4 8 4 rtp udp ip ethernet protocol stack 4 8 5 header compression 4 9 packet loss 4 9 1 packet loss mechanism 4 9 2 recovery 4 10 tips for maximizing voice quality 4 10 1 network level testing 4 10 2 voip application level testing 4 10 3 strategies

ip networks routers and addresses this module is devoted to ip used to implement layer 3 we begin with ip addressing ipv4 address classes subnets dhcp static and dynamic addresses public addresses private addresses and nat we ll use the simplest ip network to explore how routers implement the network by relaying packets from link to link and also act as a point of control to deny communications based on ip address and or port number we ll complete the chapter with ipv6 addressing telecom module 14 detailed outline 14 ip networks routers and addresses 14 1 definition of network 14 2 ipv4 address classes 14 2 1 packets and network addresses 14 2 2 historical network classes 14 2 3 class a b and c 14 2 4 network id and host id 14 2 5 class d and e 14 2 6 dotted decimal notation 14 3 subnets and classless inter domain routing 14 4 dhcp 14 4 1 dynamic addresses for clients 14 4 2 static addresses and dns for servers 14 4 3 dhcp client server communications 14 4 4 dhcp message exchange 14 4 5 lease expiry 14 4 6 dhcp to assign static addresses 14 5 assigning subnets to broadcast domains 14 6 ip network routers connected with point to point circuits 14 6 1 broadcast domain at each location 14 6 2 edge router at each location 14 6 3 default gateway 14 6 4 packet creation 14 6 5 packet transmission from the source 14 6 6 ip to mac address resolution protocol arp 14 6 7 packet routing 14 6 8 overbooking bandwidth on demand 14 7 routers and customer edge 14 7 1 customer edge device 14 7 2 router connects broadcast domains 14 7 3 routing 14 7 4 denying communications 14 7 5 packet filtering 14 7 6 port filtering 14 7 7 firewall 14 8 public and private ipv4 addresses 14 8 1 public addresses 14 8 2 regional internet registries 14 8 3 unassigned or private addresses 14 9 network address translation 14 9 1 network address translator 14 9 2 outbound 14 9 3 inbound 14 9 4 advantages of nat 14 9 5 implementation 14 10 tcp and udp 14 11 ipv6 14 11 1 expanded addressing capabilities 14 11 2 header simplification 14 11 3 improved support for extensions and options 14 11 4 support for traffic management 14 11 5 ipv6 packet format 14 12 ipv6 address allocation and address types 14 12 1 internet registry

identification 14 12 2 sites and global routing prefix 14 12 3 interface id 14 12 4 subnet id 14 12 5 allocation 14 12 6 subnet prefix 14 12 7 ipv6 address types

optional wireless module 5 legacy 2g and 3g tdma and cdma these sections started off their lives in wireless module 3 as they were one after another in turn the latest and greatest mobile communication technology now in the dustbin of history recommended reading for anyone who wants to know what gsm really means a 2g tdma technology what cdma is and how it works the idea of spread spectrum about the 2g and 3g standards wars of the 2000s optional wireless module 5 detailed outline 5 legacy 2g and 3g tdma and cdma 5 1 second generation digital 5 1 1 spectrum 5 1 2 incompatible spectrum sharing technologies 5 1 3 cdma is 95 5 1 4 tdma is 136 5 1 5 gsm 5 2 tdma is 136 time division multiple access 5 2 1 tdma 5 2 2 is 136 and d amps 5 2 3 capacity increase 5 2 4 inefficiency 5 3 tdma gsm 5 3 1 spectrum sharing method 5 3 2 inefficiency 5 3 3 data gprs and edge 5 3 4 terminology misuse of the term gsm phone 5 4 cdma code division multiple access 5 4 1 carriers 5 4 2 codes 5 4 3 forward error correction 5 4 4 variable rate coding 5 4 5 packetized voice and data 5 4 6 qualcomm is 95a and is 95b 5 5 spread spectrum 5 5 1 chips and chipping rate 5 5 2 spreading 5 5 3 direct sequence vs frequency hopping 5 5 4 error correction 5 5 5 rake filters and multipath 5 6 cdma operation and patents 5 6 1 communication via multiple base stations 5 6 2 multipath 5 6 3 soft handoffs 5 6 4 walsh codes and pseudonoise 5 6 5 base station identification short codes and timing 5 6 6 power control 5 6 7 qualcomm 5 7 3g cdma 1x umts and hspa 5 7 1 imt 2000 5 7 2 1x 5 7 3 data optimized carriers 5 7 4 capitulation

the osi layers and protocol stacks there are so many functions that must be performed to interoperate systems a structure is required to organize the functions so that separate issues can be treated separately we ll explore the most commonly used structure the iso open systems interconnection 7 layer reference model you ll learn what a layer is the purpose of each layer examples of protocols like tcp and ip used to implement layers and gain a true understanding of how a protocol stack works for applications like web surfing and voip telecom module 12 detailed outline 12 osi layers and protocol stacks 12 1 protocols and standards 12 1 1 functions to be performed 12 1 2 monolithic vsstructured protocols 12 1 3 open systems and standards 12 2 iso osi reference model 12 2 1 layers 12 2 2 separability of the layers 12 2 3 protocol stacks 12 3 the osi 7 layer model 12 4 physical layer 802 3 dsl docsis wireless 12 5 data link layer 802 mac 12 5 1 lans frames and layer 2 switches 12 5 2

mac frames and mac addresses 12 5 3 other data link protocols 12 6 network layer ip and mpls 12 6 1 packet switched networks 12 6 2 routing table updates 12 6 3 mpls 12 7 transport layer tcp and udp 12 7 1 reliability 12 7 2 port numbers 12 8 session layer pop sip http 12 8 1 password authentication 12 8 2 authentication servers 12 8 3 password caching 12 8 4 cookies 12 8 5 client server sessions 12 8 6 peer peer sessions 12 9 presentation layer ascii encryption codecs 12 9 1 character coding 12 9 2 e mail coding 12 9 3 codecs 12 9 4 data compression 12 9 5 symmetric encryption private key 12 9 6 asymmetric encryption public key encryption and digital signatures 12 9 7 example of separability of layers 12 9 8 example of peer protocol 12 10 application layer smtp html english 12 10 1 email 12 10 2 more application layer examples 12 11 protocol stacks 12 11 1 example surfing 12 11 2 voice over ip 12 12 protocol stack in operation ukrainian dolls 12 12 1 communications flow 12 12 2 segmentation at each layer 12 12 3 nested headers 12 13 standards organizations 12 13 1 iso 12 13 2 dod and ietf 12 13 3 itu and bellcore 12 13 4 tia and ieee 12 13 5 3gpp 12 13 6 ansi

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